How Assessing Plasticity Design Choices Can Improve UI Quality: A Case Study

Audrey Serna, Gaëlle Calvary, Dominique Scapin

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Audrey Serna
LIG laboratory
385 rue de la bibliothèque
BP 53, 38041 Grenoble Cedex
France
Audrey.Serna@imag.fr

Gaëlle Calvary
LIG laboratory
385 rue de la bibliothèque
BP 53, 38041 Grenoble Cedex
France
Gaelle.Calvary@imag.fr

Dominique L. Scapin
INRIA
Rocquencourt - B.P. 105
78153 Le Chesnay Cedex
France
Dominique.Scapin@inria.fr

ABSTRACT

In Human Computer Interaction, plasticity refers to the capacity of User Interfaces (UIs) to withstand variations of context of use while preserving quality in use. Frequently, insuring more or less smooth transition from one context of use to the other (from the end-user perspective) is conducted ad hoc. To support a more systematic approach for characterizing UI tuning in terms of quality in use along context of use variations, we present an exploratory study focused deliberately on platform aspects. The design process of this particular case study is detailed and all design decisions have been recorded in terms of their influence on UI ergonomic quality, using Ergonomic Criteria. The interesting result is that most design choices when changing the platform lead to the reexamination of the initial designs. Ongoing work is done to support the insight that considering plasticity seems to help in explicitly broadening UI design choices and sharpening the solution.

Author Keywords

Plasticity, UI design, quality in use.

ACM classification

H.5.2 User Interfaces: Evaluation/methodology.

General terms

Design

INTRODUCTION

Plasticity is the ability of User Interfaces (UIs) to adapt to the context of use (<user, platform, environment>) while preserving quality in use [18]. Among the three keywords of the definition (adaptation, context of use, and quality), the most developed so far is UI adaptation. Adaptation may involve remolding and/or redistribution [3]. Remolding transforms the UI without changing its distribution among the available interaction resources. On the contrary, redistribution changes the UI distribution and may require remolding to tailor the UI to the targeted context of use. Remolding may occur at different levels of abstraction [1] ranging from the task level to the concrete presentation.

From the designer's perspective, most of the time the focus is set on the platform dimension of the context of use ([5] and [8] for example). Regarding ergonomic quality, changing the platform is frequently considered at first sight as a set of constraints for the new UI. For example, remolding large-screen UIs for fitting small-screens is expected to result in an alteration of legibility and information density if the same information is provided similarly on both platforms. However, to our knowledge, no systematic approach has been followed to analyze the consequences of platform switches on ergonomic UI quality.

Indeed, usability has been widely investigated (for example Ergonomic Criteria [15], QUIM [16] or ISO standard [9]) for interactive systems, usually not integrating plasticity concepts. Nevertheless, little work has been conducted from a usability point of view, regarding the ergonomic UI quality during adaptation. [6] elicits UI transformation rules for targeting a more constrained platform in terms of screen size for instance, but the quality of the source UI is not considered at all. On the contrary, [10] recommends that a design strategy should achieve design independence by starting with the most limited device. [14] introduces transformational consistency among cross platform applications design. Providing immediate feedback helps the designer to overcome the trade-off between device optimization and cross device consistency. From the evaluation perspective, [7] presents a method to evaluate multi-device consistency. In addition to consistency issues, [4] addresses the problem of inter-usability of multi-device systems. The authors introduce design principles to maintain service continuity in inter-device transitions: inter-device consistency, transparency and dialogue adaptation. However, many other aspects of inter-usability are still not defined and no systematic approach is offered.

To step forward toward a more systematic method, the use of case studies can get rid of prejudices and support the basis of theoretical foundation. A first step in that direction consisted in characterizing, for one particular exploratory study, the evolution of ergonomic quality when designing an application with platform variations. We chose to focus

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voluntarily on platform aspects. Later on, the other changes in context of use (user and environment aspects) will need to be integrated in the analysis.

In this study, the perspective was to use existing user-oriented metrics for observing UI quality evolution when switching platforms, through a kind of usability dashboard/ benchmark. Ergonomic Criteria are a support for inspecting and documenting evaluation of the ergonomic UIs quality [15]. The framework is structured along 18 elementary criteria that act as good predictors of UI quality (see for instance [2]). We chose to use this benchmark since it can be used for designing each version of the plastic UI, but using other inspection techniques would probably have, overall, resulted similarly, despite potential differences in problem coverage.

To sum up, this paper presents an exploratory case study for the design of a multi-platform e-government service. We describe the detailed design process, including the different iterations from one platform to another. For each iteration, the evolution of ergonomic quality is discussed according to the design choices made. Primarily results give an insight into how assessing plasticity design choices can improve the quality of UI. Ongoing and future works are presented to support this first step toward systematic means of assessing the consequences of plasticity on UI.

RUNNING the CASE STUDY

Description

The case study concerns a service for students from vocational high schools. BRPE (acronym for "Regional Scholarship for First Equipment") is a governmental program to financially support students purchasing their equipment for technical courses (for instance, scissors set for hairdressing program). Until now, the application process was fully manual. At the beginning of the academic year, high school principals are in charge of informing students about the agenda and procedures for applying to the BRPE scholarship. They provide the paper form to applicants. For students under the age of majority, their parents or legal tutor are the ones allowed to fill the form. The forms and associated documents required (e.g. bank account statement) are given back to high school principals who are in charge of controlling the completeness of forms and sending the complete ones to the Regional Administration. Regional agents process the students' applications. If an application is accepted, the accounting department pays the scholarship through bank transfer to the bank account of the student (or his parents/tutor).

Global design process

Computerizing the process raises several issues:

- The form will have to be adapted: some part of the form may be dynamic (for example, the section concerning the student's age); other parts may disappear or be replaced by other ones (for example, the information confirmation by the high school principal).
- The emphasis must be on guiding students through the application process. Applying to BRPE must be easy and pleasant.
- The system must ensure observability of the application process and state. Students must be able to monitor their application progress whenever they want to. Offering to the user a view of the workflow in which his procedure is anchored is a key feature for e-services.

The study is focused on the students' part of the system. Figure 1 presents system specifications in terms of task models. The management of applications by regional agents is not described here.

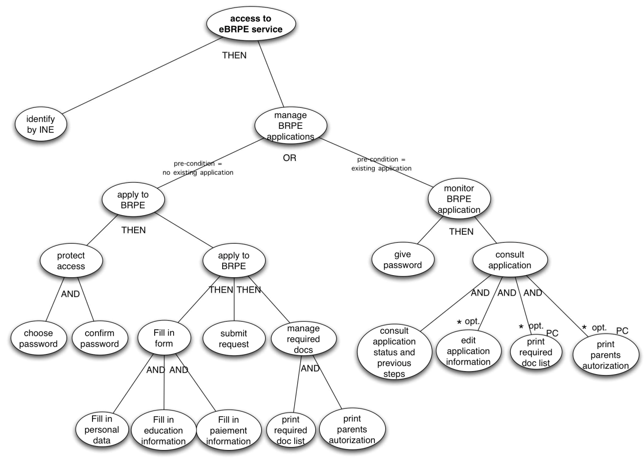


Figure 1. BRPE task model for the e-service

The approach adopted here is a step-by-step development. Based on the paper form, we first developed a version of BRPE for PCs, and then for iPhone. We call these steps "inter-platform iterations" (Figure 2). Inter-platform iteration consists in adapting UI from a source platform to a target platform. Each step of the iterative process was followed by an ergonomic inspection (performed by one or two experts on the Ergonomic Criteria benchmark). The ergonomic problems detected during these inspections led to iterations to improve the UI quality. Some of these problems implied only changes on the current platform prototypes. These changes are called "local iterations" (Figure 2). Those that question design decisions taken at an earlier step in the design process and require adjustments in the previous platform prototype are called "retro-iterations" (Figure 2).

A total of 8 iterations have been carried out for the multi-platform prototypes development: 4 iterations for PC and 4 for iPhone. In addition, 1 iteration for the paper form has been identified but not applied. Table 1 summarizes the different iterations.

Iterations 1, 2 and 3

The first three iterations deal with the development for PCs. As BRPE had never been computerized before, the first iteration had several ergonomic deficiencies. Two local iterations have been required to fix the identified problems.

Mainly four ergonomic criteria were found to be improved:

- *Consistency*: UI elements were too disparate and items homogenization was required. We proceeded with a classification of functional elements and a categorization of their aspects.

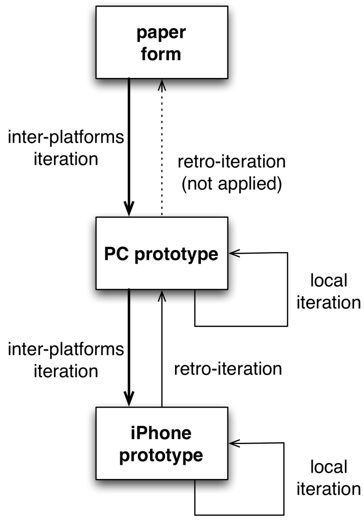


Figure 2. Design process with iterations between prototypes

	Iteration
0	Existing paper form
1	Inter-platform iteration: Prototype for PC
2	Local iteration on PC prototype
3	Local iteration on PC prototype
4	Inter-platform iteration: Prototype for iPhone
5	Local iteration on iPhone
6	Local iteration on iPhone: (Stepped application form version)
7	Retro-iteration on PC platform
8	*Retro-iteration on paper form (not applied)*
9	Local iteration on iPhone (Corrections on PC prototype repercussions)

Table 1. Iterations summary

- *Prompting*: we observed a lack of guidance. A lot of administration terms had to be explained (for example what is the INE number, where can it be found, etc.) and the different guidelines to apply to a BRPE grant had to be added. Monitoring the progress of the student application was not very clear and had to be reconsidered.
- *Legibility*: some elements of the visual and graphic identity chosen for the UI were not convenient and disturbed legibility.
- *Prevention against error*: some important actions on the form (such as submit the application or erase the fields values) were not protected with confirmation dialog windows.

Iteration 2 allowed to fix most of these problems. Iteration 3 dealt with improving the monitoring part of the system.

At this stage of the process, we considered the ergonomic quality of the prototype for PC platform satisfactory enough to develop the iPhone prototype.

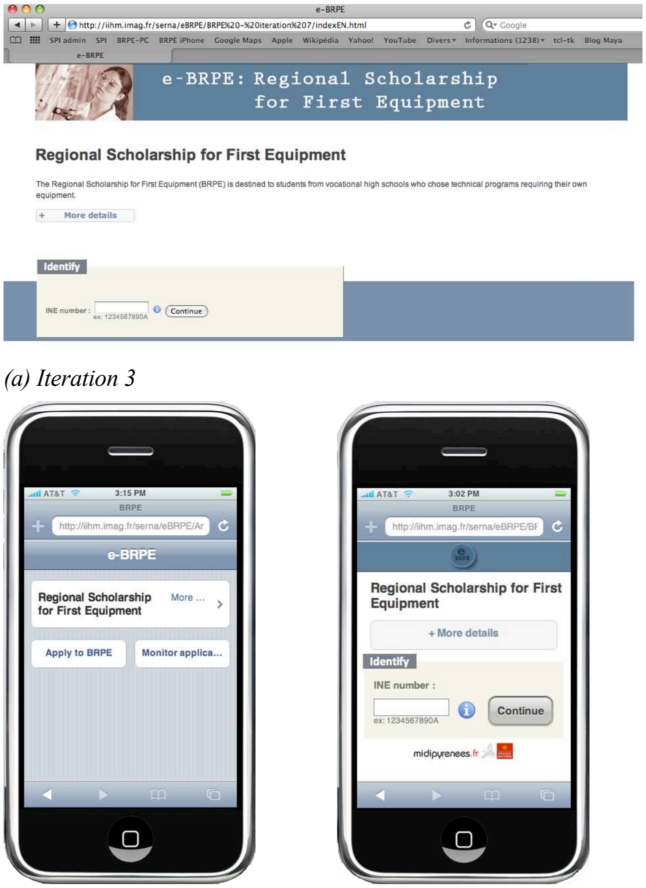
Iterations 4 and 5

For the inter-platform iteration 4, the major decision concerning the aspect of the UI was to favor the compatibility with iPhone web applications. We decided to use the pages layout and transitions common to iPhone web apps, which look like navigation lists [1]. Figure 3 (b) represents the e-service home page for the first iPhone prototype (iteration 4). However, the decision to adopt the iPhone applications "look and feel" has adverse effects on:

- *Consistency*: the aspect of the prototype did not correspond to the aspect of the first prototype developed for the PC platform. One of the consequences is that switching from one platform to another, the user may be disoriented.
- *Minimal actions*: to access information, the user had to navigate constantly through several levels of list items, increasing the number of actions necessary to complete the task.

For iteration 5, we started over the prototype with the objective of using adapted visual and graphical styles from the PC platform. Figure 3 (c) presents the home page for the iPhone prototype in iteration 5. When compared to Figure 3 (a) illustrating the home page of the PC prototype, we can see that the look and feel of the PC prototype is respected. However some elements have been adapted to the target platform.

- *Items aspects*: the height, width, font size of elements is modified to suit the constraints links to the platform features (tactile interaction, screen size, etc.). For example, buttons are enlarged to be reachable with a finger. Items concerned: top-banner, links, buttons and dialog windows.
- *Items layout*: the spatial organization of elements is modified to fit the reduction in screen size. For example, on the application form, most of the text fields are presented line by line whereas in the PC prototype there can be 2 or 3 text fields on the same line. Items concerned: fields' layout in the form, buttons layout.
- *Items labels*: to fit the new aspect of some elements, their labels had to be shortened. For example, substantive form is used instead of a verb. In certain cases, the transformation may alter the quality of the label. In this case, we give priority to legibility on significance of codes. Items concerned: buttons label.
- *Items behavior*: the dynamic behavior of elements displaying additional information is adapted. To avoid multi-windows occurrence, the display is transformed into pages with a back button located at the top left of the page (to respect iPhone applications compatibility). Items concerned: tool-tip prompting and pop-up windows displaying optional information.
- *User tasks*: tasks that cannot be performed on the target platform are not presented on the UI. Prompting text replaces the task if this latter is mandatory for the completion of the global task. Items concerned: documents printing and visualization tasks.



(a) Iteration 3

(b) Iteration 4

(c) Iteration 5

Figure 3. Home page of eBRPE through the different iterations (translated from French)

The ergonomic inspections of these two iterations showed dependencies between criteria. The design decisions made to favor such and such criterion can poorly influence other criteria. If the ergonomic quality is judged unsatisfactory, a local iteration can be conducted to find a trade off between the conflicting criteria. It is the case in Iteration 5, we chose to favor consistency and minimal actions criteria against compatibility (to iPhone web apps). In the same way, we favored legibility instead of significance of codes when needed.

Iteration 6

The prototype resulting from iteration 5 raised one major problem considering the application form. The form was displayed on a unique page. The user had to scroll to complete the form and to choose an action to carry out on that form, such as submitting the final application. In terms of ergonomic dimensions, the problematic criteria are:

- *Information density*: the form contains too much information to fit into the screen size while conserving legibility. As a result, the form is longer than the screen height and the user has to scroll to glance through the form.
- *Prevention against error:* The risk is that the user does not scroll and does not understand the form completion.

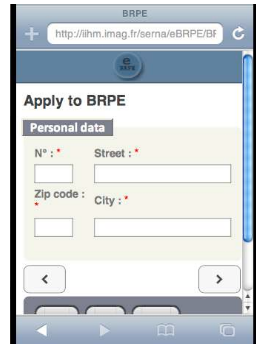


Figure 4. Iteration 6 - Extract of the stepped form

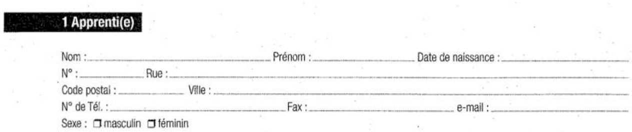
In response to these problems, we chose to develop a stepped version of the application form (iteration 6). Figure 4 presents a page of the stepped form. Each field set identified in the previous prototype is broken up into small steps that fit into a page. To move into the form, navigation buttons ("<" to go to the previous step and ">" to go the next step) are added just after the fields. Quality in terms of information density and error protection increases, but decreases in terms of minimal actions. Indeed the navigation system increases the number of actions to complete the form. In addition, users loose the overview of the process. Here, we have a good example of dependencies between criteria and of the necessity of trade-off. We chose to keep the stepped form version and to favor error protection.

Iteration 7, 8 and 9

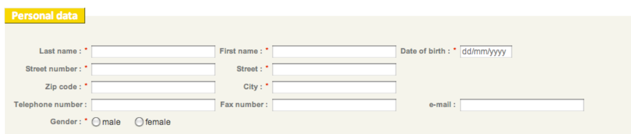
Iteration 6 raised two major problems with regard to the guidance dimension:

- *Grouping / distinction between items by location* for personal data form: when breaking up the personal data field set, we noticed that fields were not logically grouped. In consequence, some fields that should have appeared into the same page were located on different pages.
- *Compatibility to task* and *Grouping / distinction between items by location and by format* for actions buttons layout: in iteration 6, the action buttons were located in the last page of the application form. As a result, erasing fields values or saving the application process were not accessible at anytime anymore (problem in terms of compatibility to the task). Some of the actions buttons had to be displayed on each page of the stepped form. This issue leads to another problem. In the PC version, buttons were grouped according to the concept which they applied on: one group for the data captures concept (erasing fields value or canceling the data capture) and one group for the application concept (saving the data and submitting the application). The second group raises the problem of grouping and distinction between items. Indeed, saving the application process must be accessible at anytime in the stepped form whereas submitting the application can only be once the whole form is completed.

These problems reflect bad decisions in previous prototype design and imply a retro-iteration on the PC prototype (iteration 7). The changes made on the PC prototype have been then spread over the iPhone prototype (iteration 9). In more details, fields of the personal data form have been grouped according to small conceptual units. Figure 5 illustrates the evolution of the form design for both platforms among the iterations. These changes could be applied to the paper form in order to improve its quality. It would be a retro-iteration on paper form (iteration 8). We did not apply this iteration because redesigning the manual process was not part of our concern, this being under the authority of the administration.

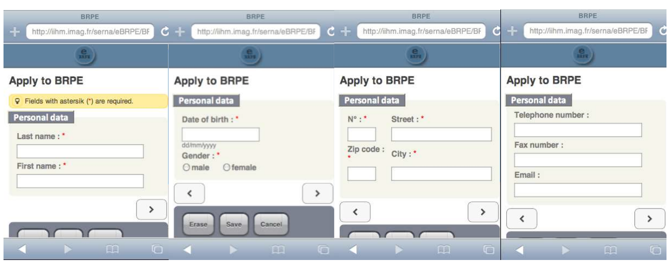


(a) Iteration 0 - Paper form



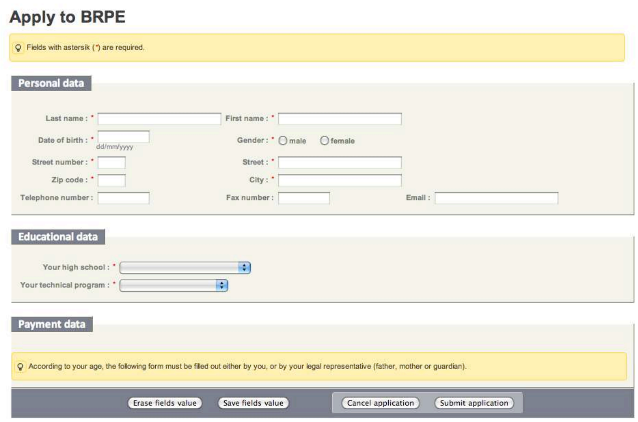
(b) Iteration 1 – PC prototype

(c) Iteration 7 – PC prototype

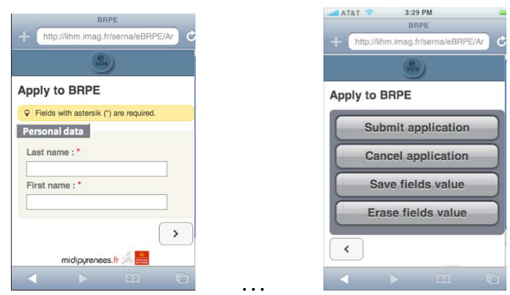


(d) Iteration 9 – iPhone prototype

Figure 5. The evolution of the "personal data" form among the iterations on both prototypes

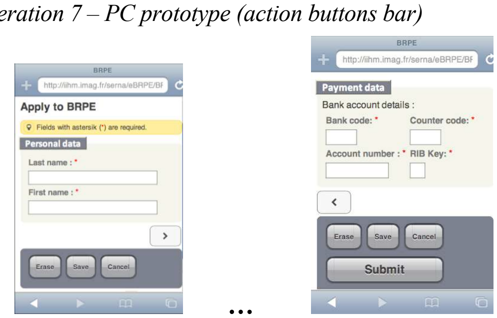


(a) Iteration 3 – PC prototype



(b) Iteration 6 – iPhone prototype

(c) Iteration 7 – PC prototype (action buttons bar)



(d) Iteration 9 – iPhone prototype

Figure 6. The evolution of buttons form among the iterations on both prototypes

Figure 6 illustrates the evolution of action buttons layout design for both platforms among the iterations. In the first iterations, buttons were grouped according to the concept on which they were operating. In iterations 7 and 9, buttons have been grouped according to accessibility of the buttons within the form. For the stepped version of the iPhone prototype, for erasing field values, canceling or saving the application, process buttons are available in each page of the stepped form whereas the submit button is only accessible on the last page of the form.

PRELIMINARY RESULTS AND FUTURE WORK

Looking for systematic means of assessing the consequences of plasticity on UI, from the end-user point of view, and to facilitate the designers' tasks is a complex question. Initially, the belief was that it would be possible to use currently available UI evaluation techniques (in our case, inspection using Ergonomic Criteria) for helping design, through a kind of usability dashboard/ benchmark. However, applying the approach to a case study clearly shows that before any systematic comparison of UI in different contexts (in our case, different platforms) one must make sure that all UIs are optimally designed (being aware there is no single solution).

Considering the quality of the source UI is very important to clearly distinguish concerns between degradations (resp. beautifications) due to the change of platform versus evolutions triggered by the change of platform but feasible on the source platform. The side effect of this result is that designing plastic systems lead to improve the ergonomic quality on other platforms, simply because it facilitates the iterations among the various design solutions based on certain usability dimensions that may influence other usability dimensions. Also, this shows that among the set of potential solutions, some are some more easily transferable to other contexts of use.

This study is of course limited to the platform migration and to one particular e-government application. Further work will extend the approach to other context migrations (user and environment variations), and will be applied to other case studies. Efforts will be concentrated on building a method offering design guidance for developing plastic systems with respect to ergonomics. To improve guidance, we plan to develop tools for representing ergonomic inspection results for helping to visualize and quickly identify the weaknesses of one version and of the adaptation from one platform to another. This kind of tools could help, among others, designers and developers to choose the appropriate trade-off between different ergonomic dimensions. Finally, the method should be experimented by designers for validation perspectives.

Generalization of such exploratory studies may also be used to extract rules for adapting UI while preserving ergonomic quality. For example, to maintain prompting elements while preserving information density, minor information can be moved from the main page to an additional page with navigation between the two pages. Again, more case studies have to be investigated to extract and generalize such transformational rules. The perspective is to use these findings in model-driven engineering of plasticity and to integrate usability properties into model transformations as suggested in [12, 13, 17].

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